

# THX Experiment Overview

March 10, 2016

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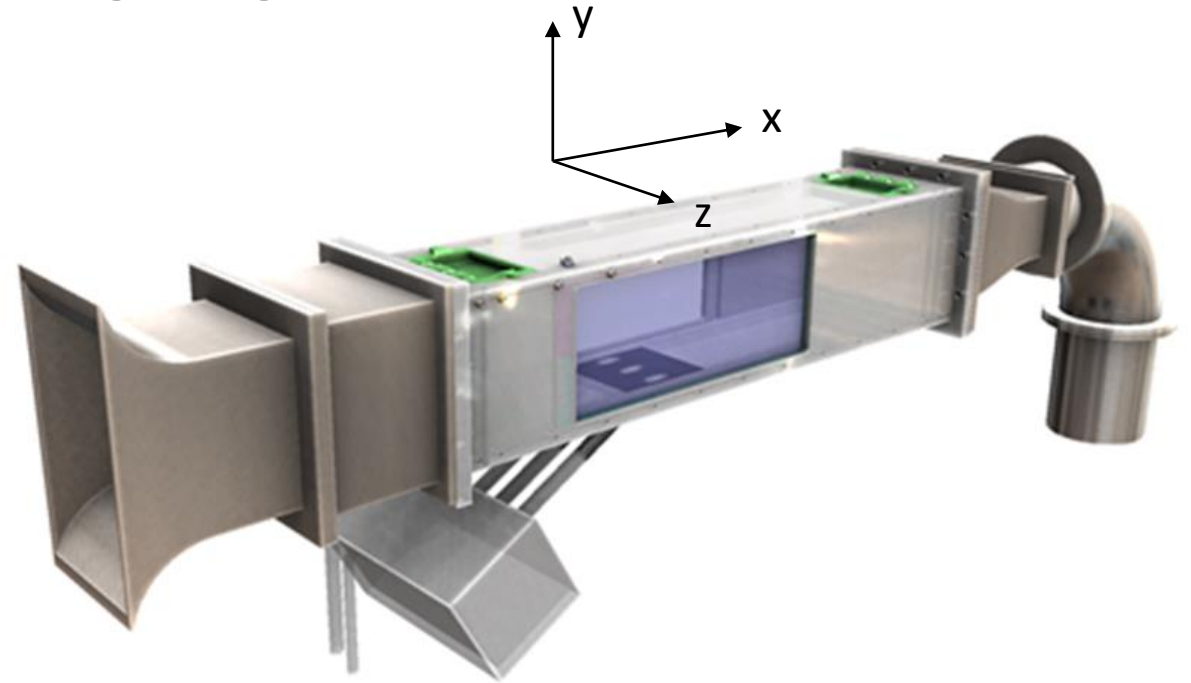
Adam Wroblewski

Randy Locke

Nick Georgiadis

# Small Scale Wind Tunnel in SW6

- Tunnel cross section: 207x207 mm
- Coordinate system shown below
- Origin for all PIV data sets: leading edge of the center hole at the floor of the tunnel

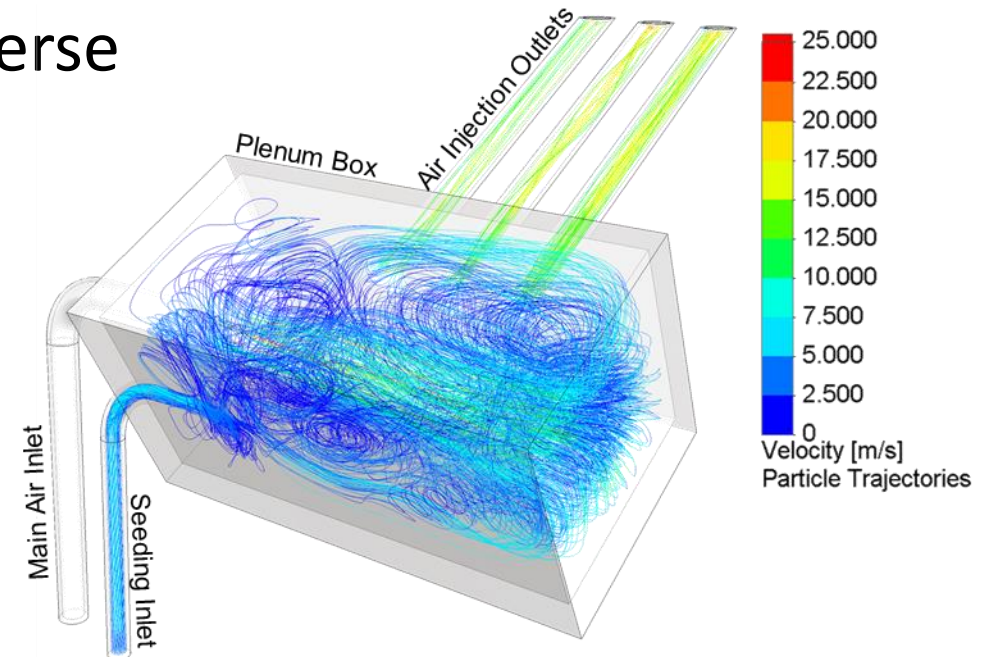


# Dual Plane PIV System Properties

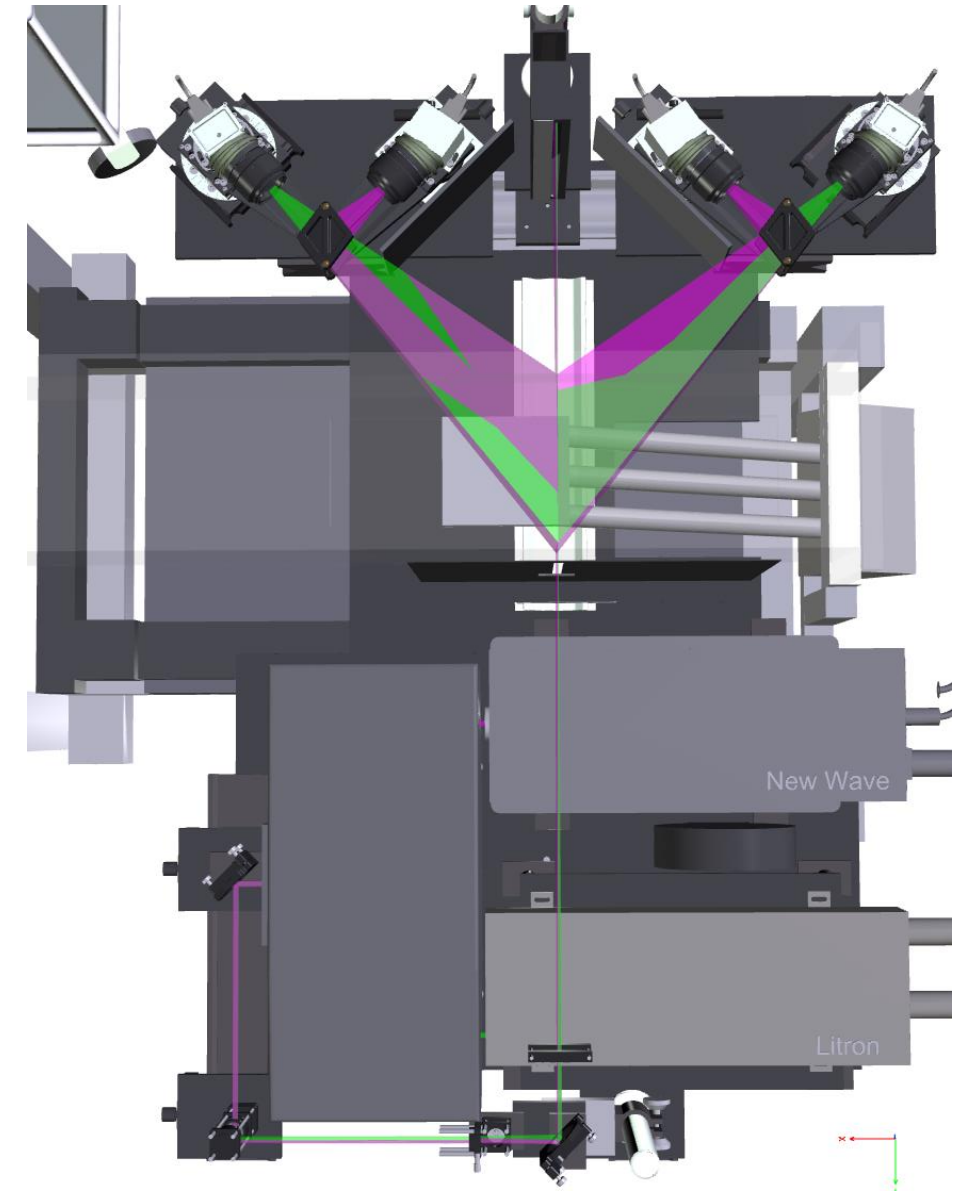
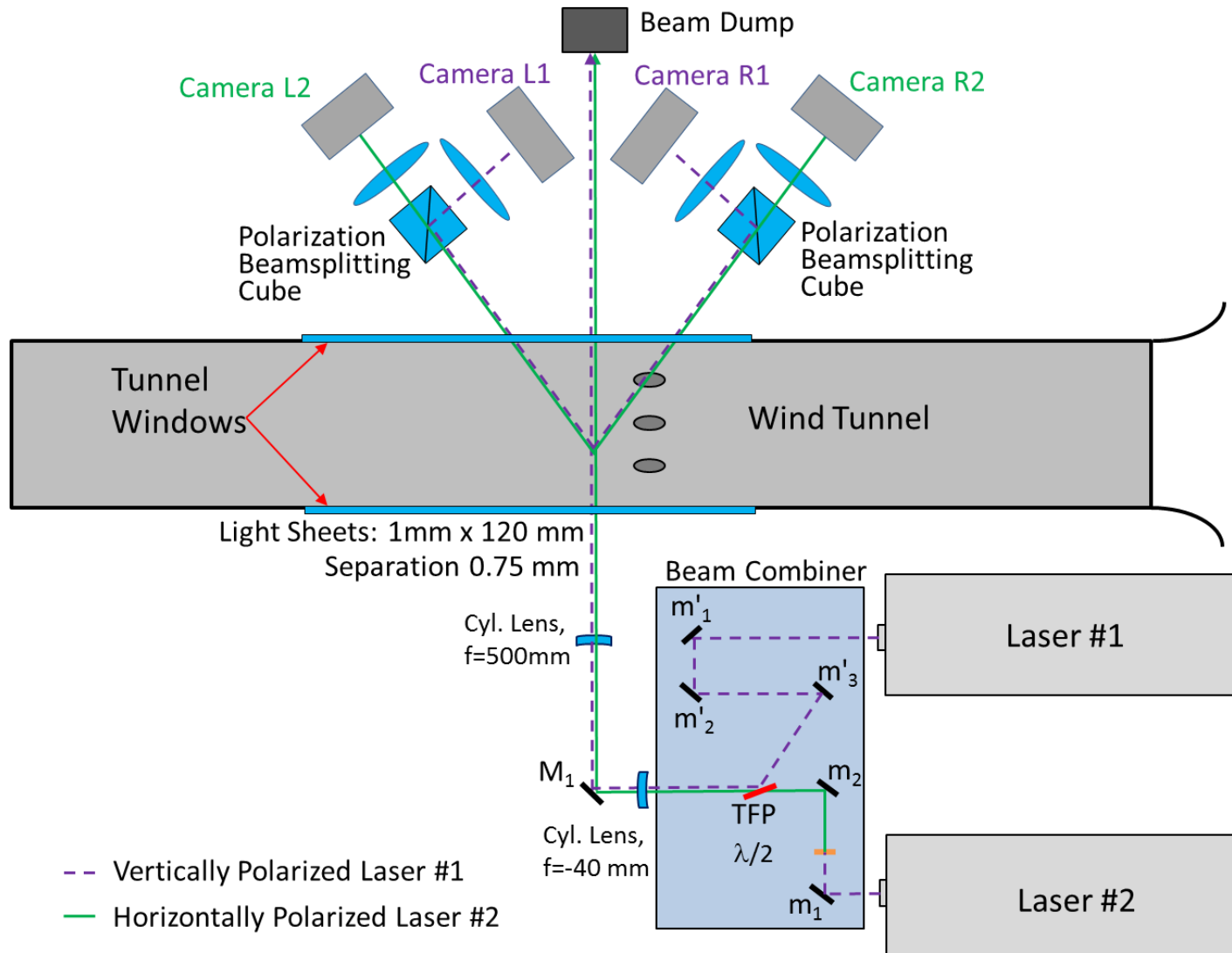
- Dual Plane PIV system used for getting all 3-components of vorticity
- Dual Plane PIV is essentially two stereo PIV systems configured to image two closely spaced laser light sheets in the flow
- ES-4020 cameras (2048x2048 pixel) cameras in Schiempflug mounts
- Two dual head 200 mJ/pulse lasers were used
- Light sheet planes were 1 mm apart, orthogonally polarized
- Polarization beam splitting cube used to isolate the two SPIV systems
- Standard SPIV data processing on each plane of data
- Cross-stream properties computed when computing ensemble average

# Dual Plane PIV Installation

- Flow seeded with olive oil using 6 Jet atomizer (Laskin Nozzle)
- Particles must be  $< 1 \mu\text{m}$  in diameter to avoid depolarization of the light
- Both the injected air and the tunnel freestream flow were seeded
- PIV system installed in SW6 facility on traverse
- Range of PIV measurements:
  - X: -31 mm to +169 mm
  - Y: +3.6 mm to +104.5 mm
  - Z:  $\pm 98$  mm



# Dual Plane PIV Installation In SW6



# Dual Plane PIV Data Processing

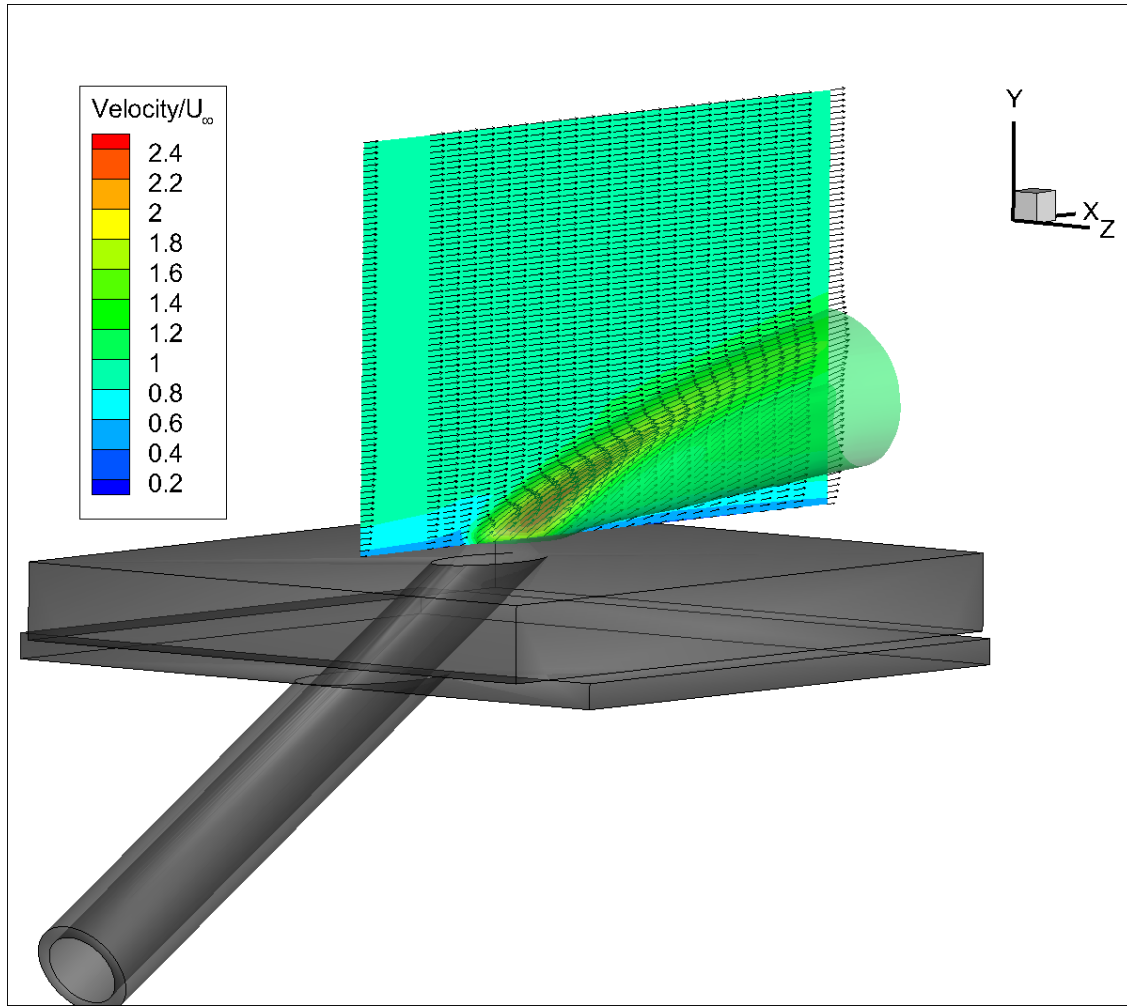
- Cross-stream planes are measured starting at: 31 mm upstream from hole leading edge, 2 increments of 25 mm and then increments of 6.35 mm
- 400 image pairs acquired at each axial station
- Standard multi-pass processing with grid refinement and subregion distortion processing
- Final subregion size 32x32 pixels on 16x16 pixel grid
- Instantaneous (single shot) PIV measurement accuracy:
  - Velocity: 1.2% full scale (8 pixel displacement)
  - Reynolds Stresses: 1.7% of full scale
- Ensemble averaging reduces errors by  $1/20^{\text{th}}$

# Processed Dual Plane PIV Data

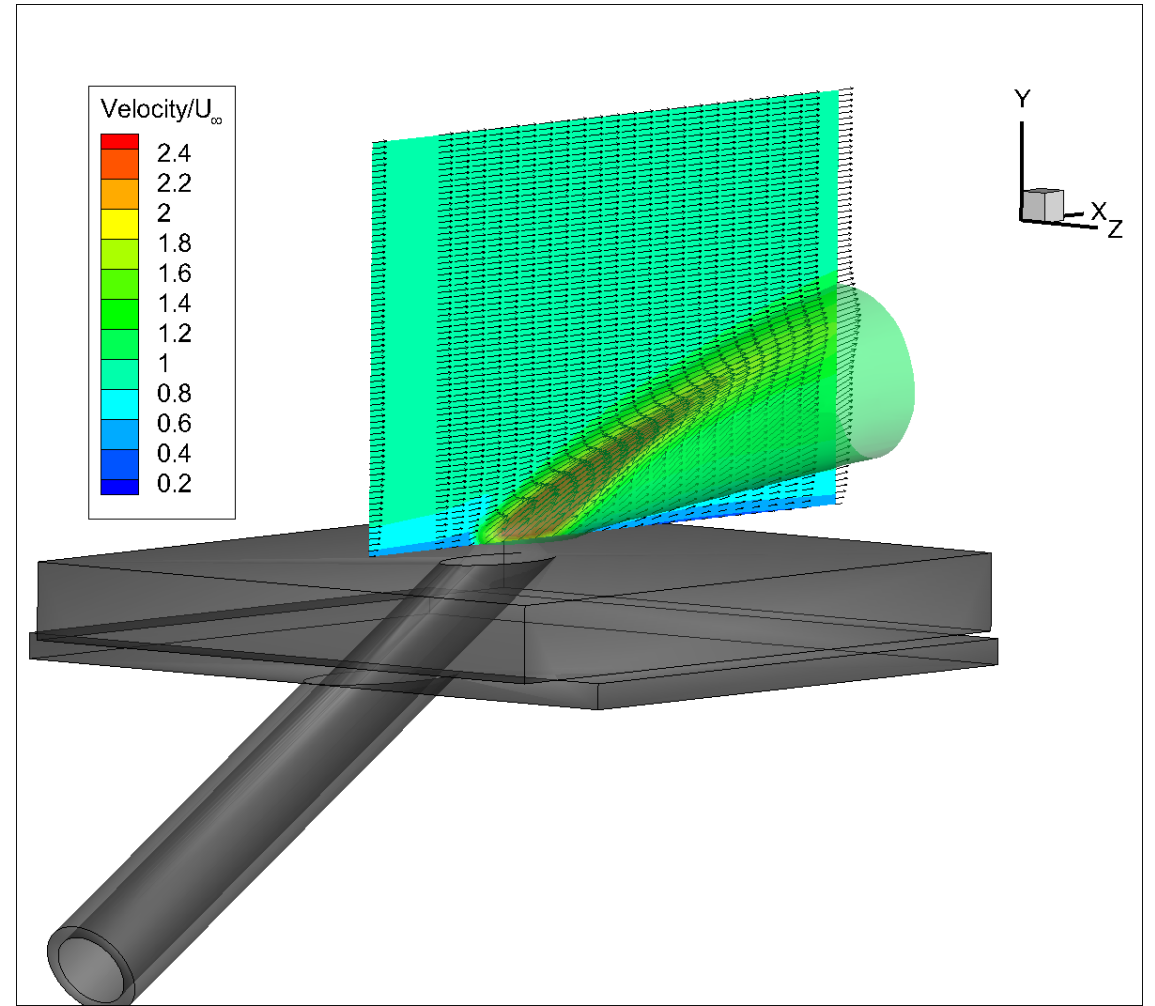
- These PIV measurements are documented in NASA TM-2016-219074
- Processed data are stored as Tecplot compatible ASCII files
  - All dimensions are scaled by hole diameter  $D$
  - Velocities scaled by  $U_{\infty}$
  - Vorticity scaled by  $U_{\infty}/D$
- Data along with the TM documenting the data are available on a DVD
  - Facility drawings in 3D pdf, sample Tecplot files, 3-hole, 1-hole model STL file
  - Table of operating conditions and temperatures

# 1-Hole, Streamwise Slice, Blowing Ratio 2

No Heat

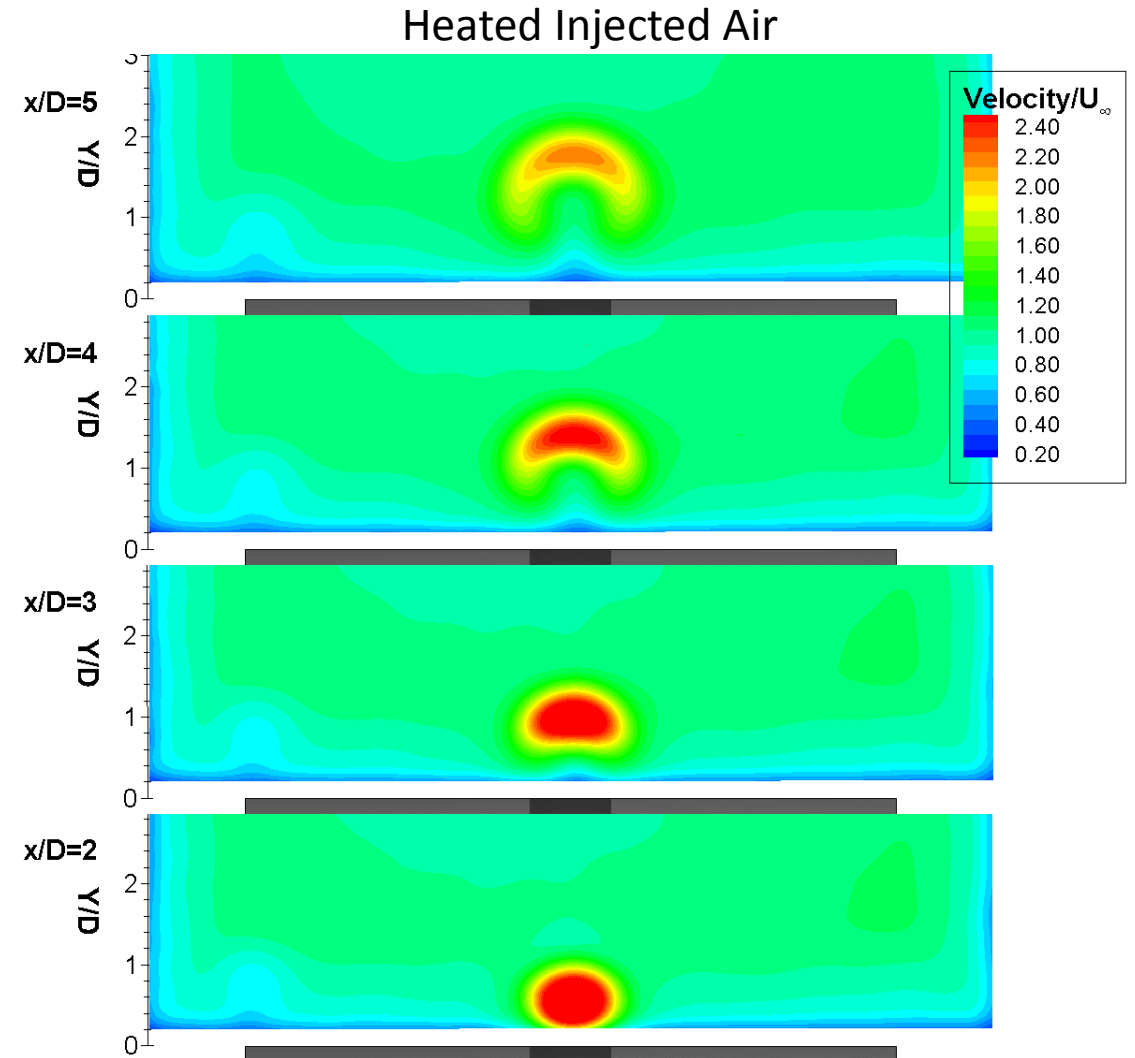
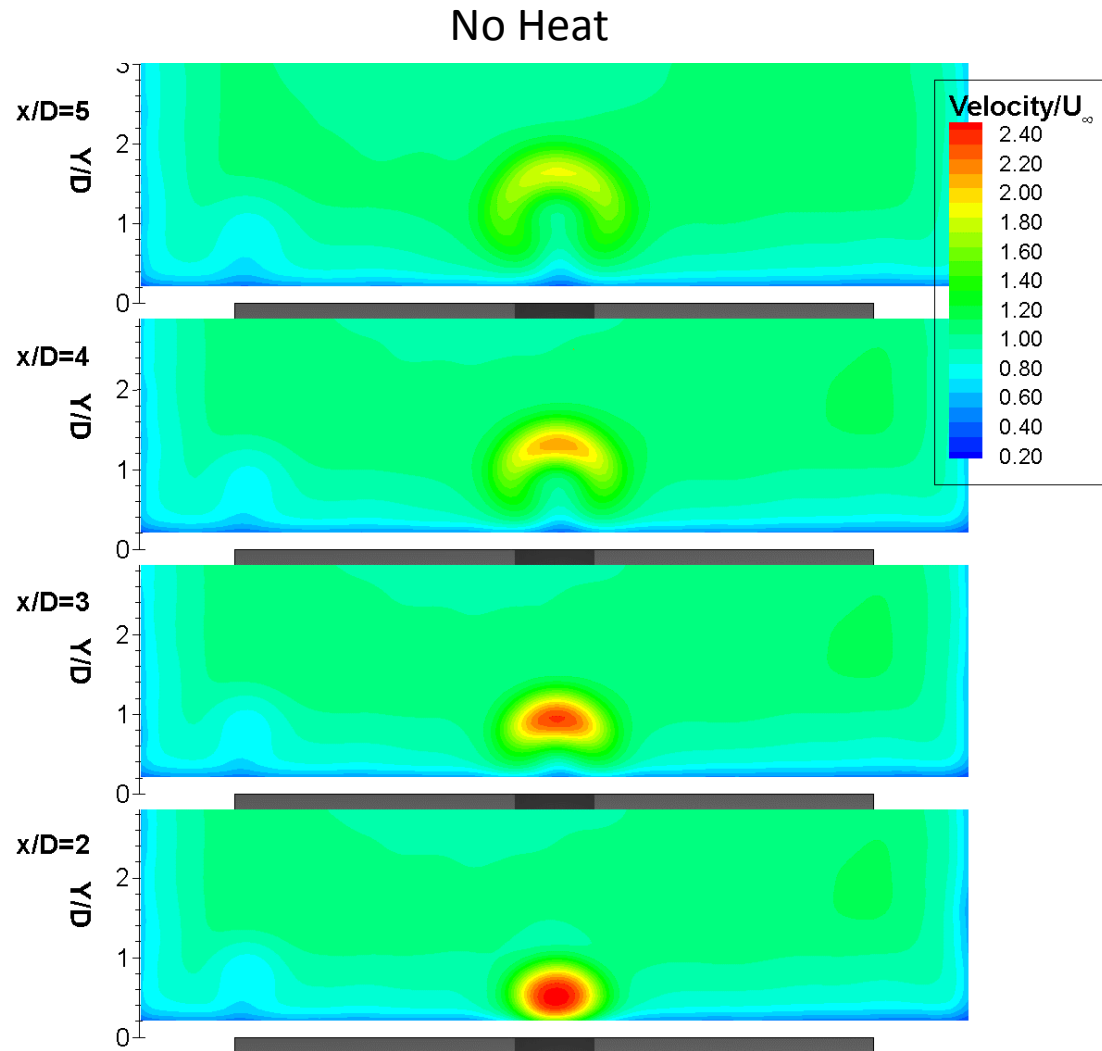


Heated Injected Air



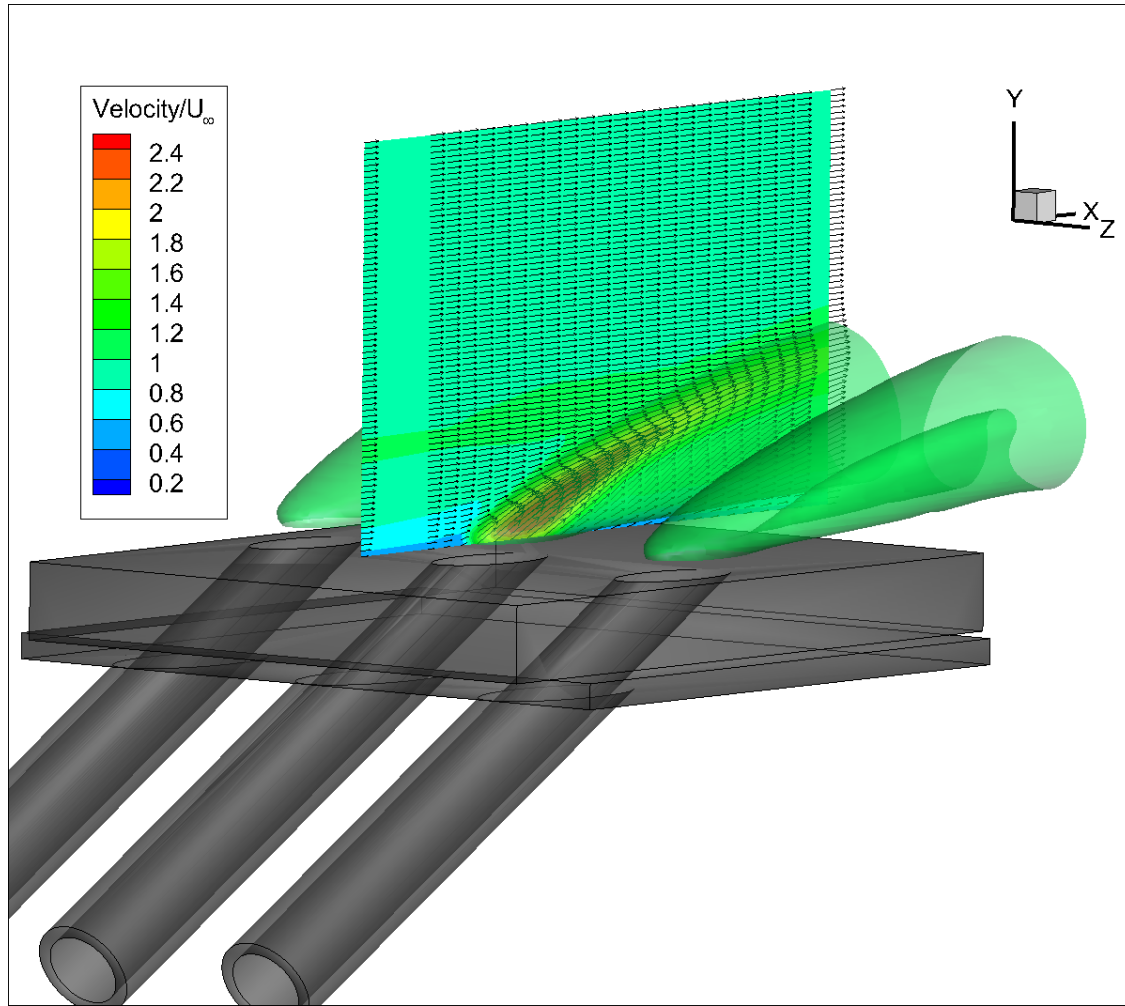


# 1-Hole, Cross-Stream Slice, Blowing Ratio 2

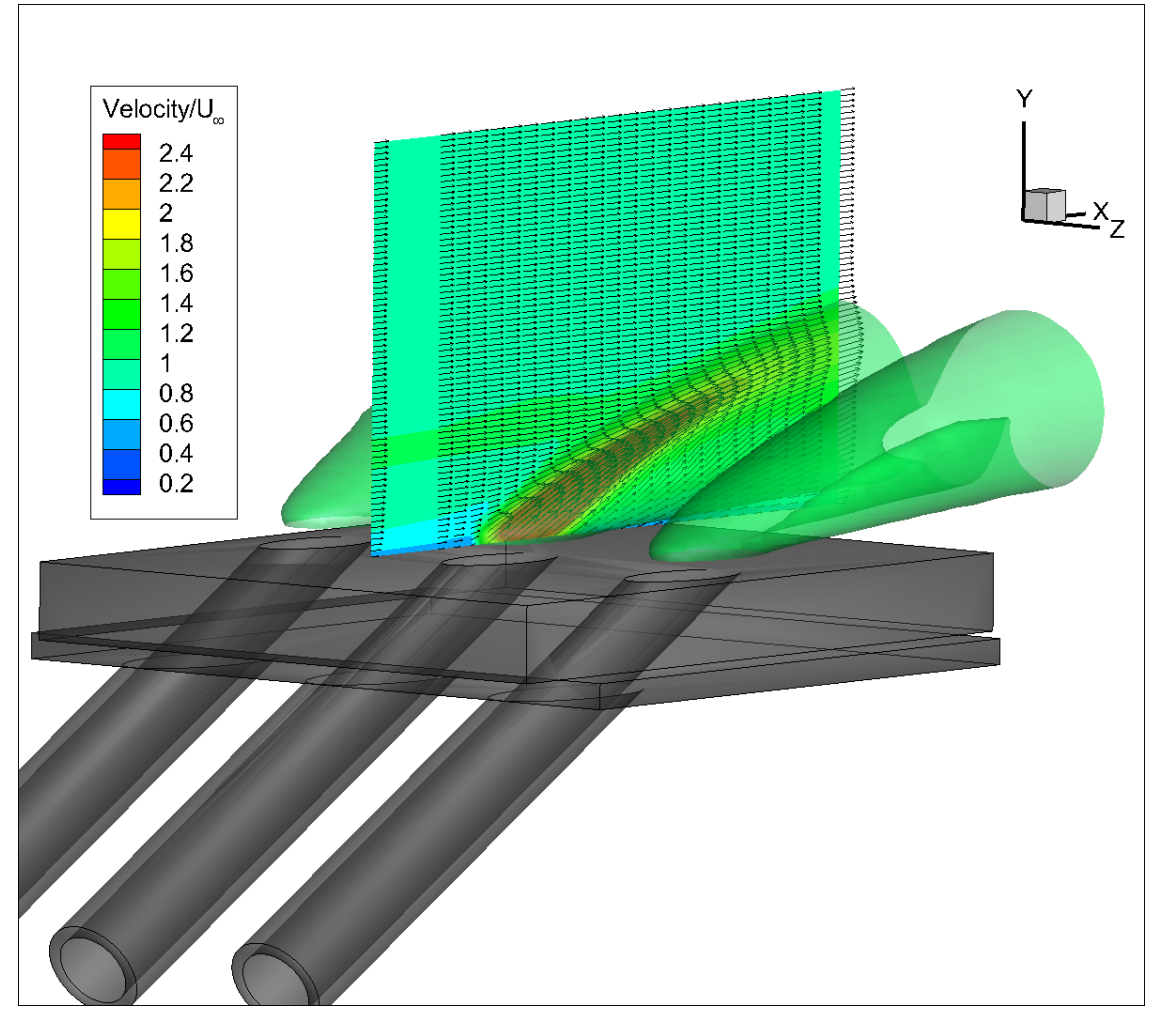


# 3-Hole, Streamwise Slice, Blowing Ratio 2

No Heat

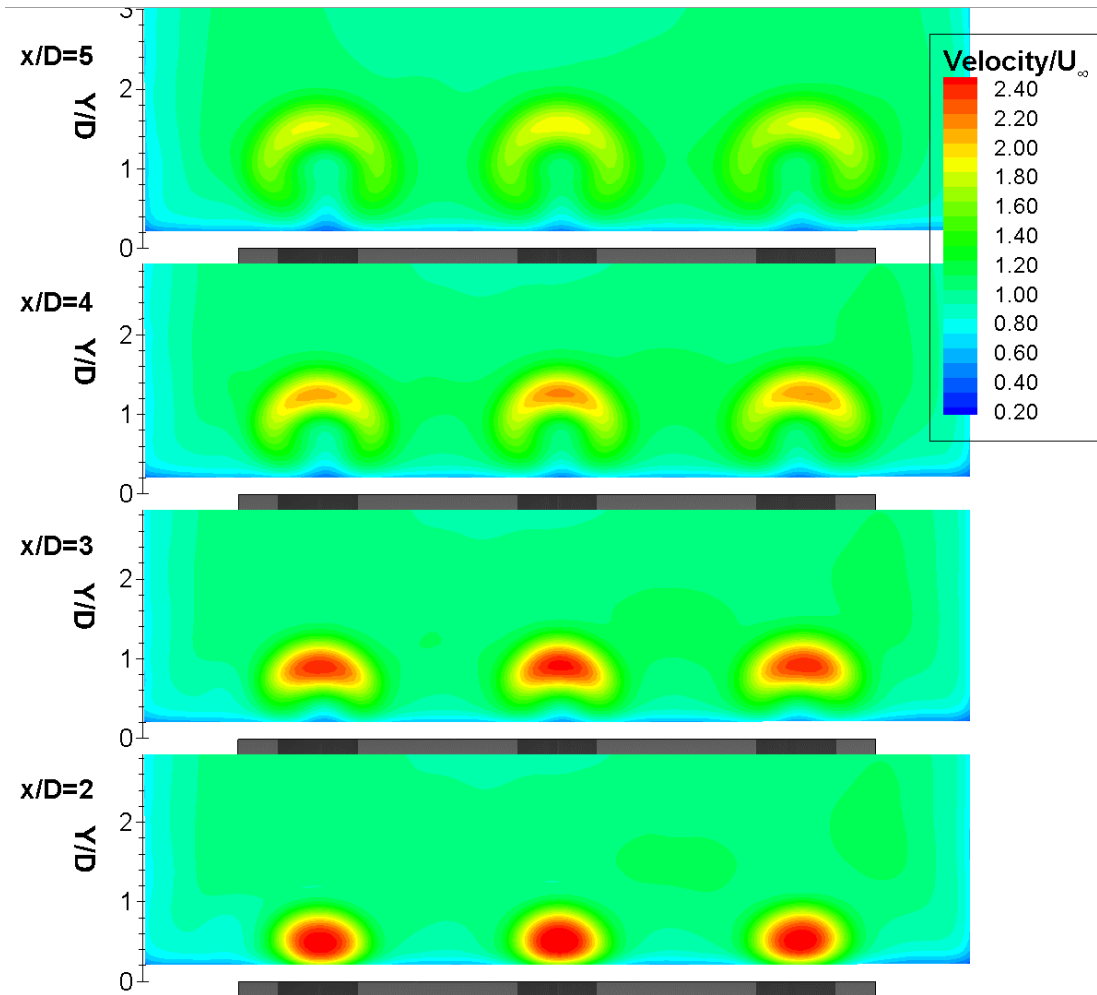


Heated Injected Air

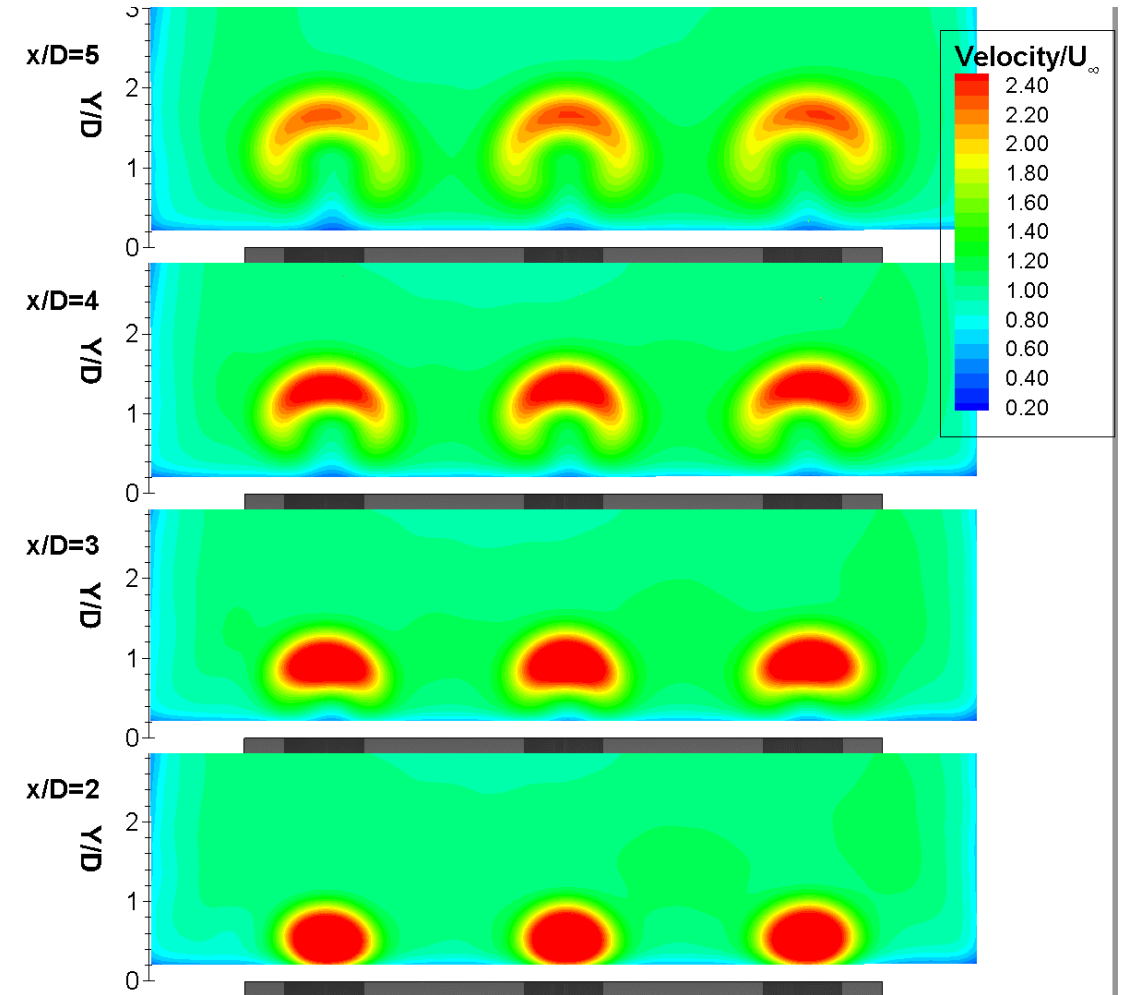


# 3-Hole, Cross-Stream Slice, Blowing Ratio 2

No Heat

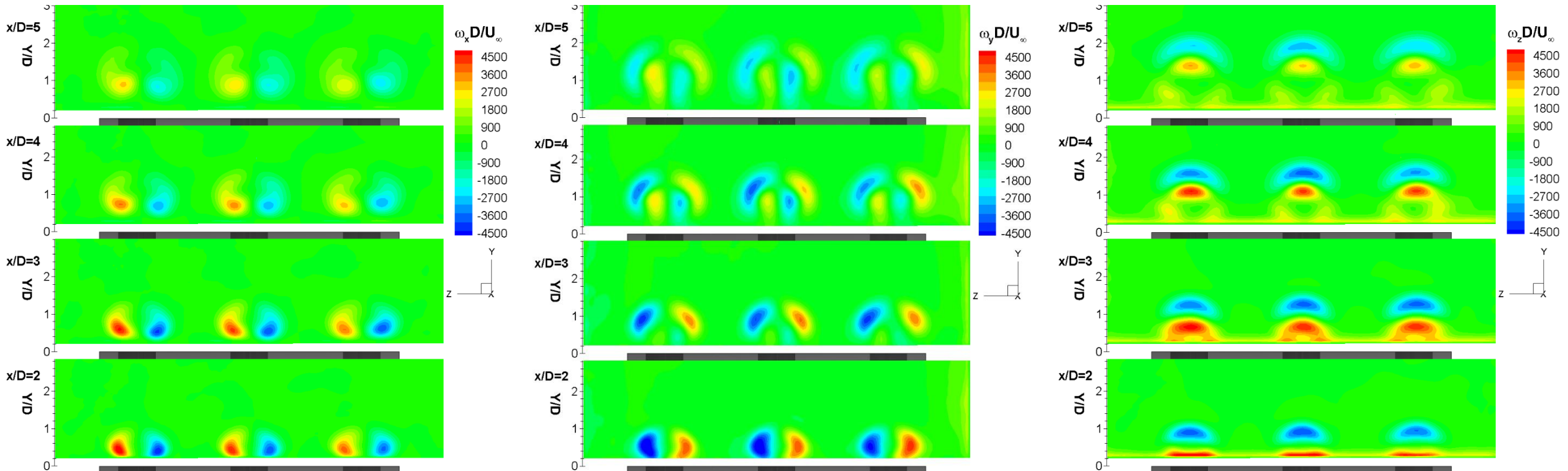


Heated Injected Air



# Vorticity

- In standard PIV or SPIV, all we get is the in-plane vorticity
- With Dual Plane PIV, we get all three



# 3-Hole, Blowing Ratio 2, w/Heat

